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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of:

LIN

Serial No. 09/084,441

Filed: May 27, 1998

Title: OPHTHALMIC SURGERY METHOD USING NON-CONTACT SCANNING LASER

Group Art Unit: 3731

Examiner: Unknown

Client Reference: LIN

Attorney Docket: 62-575

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents

Washington, D.C. 20231

Amendment not proper under 37 CFR 1.121 (see 1453)

Do not enter this Amdt

Sup 9/30/99

Sir:

Prior to an action in the above captioned application, kindly enter the following amendments and remarks.

IN THE CLAIMS

Kindly amend claims 24-36, 39-45, 48-50, 56, 59, 61, 62, 69, 70, 76-79, 82, 84, 86, 90, 91, 92, 95, 96 and 100 as follows:

A1

24. (Amended) A method for performing ophthalmic surgery, comprising:

providing [pulsing] a laser [beam] outputting a pulsed laser beam having [at] a repetition rate of at least 20 Hz, and an energy level of no greater than 10 mJ per pulse from an output coupler of said laser;

applying said pulsed laser beam onto corneal tissue; and

scanning said pulsed laser beam in a substantially overlapping pattern on said corneal tissue.

25. (Amended) A method for performing ophthalmic surgery according to claim 24, wherein:

said pulsed laser beam [provides an energy level of no greater than 10 mJ per pulse to said corneal tissue] has a repetition rate of at least 50 Hz.

26. (Amended) A method for performing ophthalmic surgery according to claim 24, wherein:

[said laser beam provides an energy level of no greater than 20 mJ per pulse to said corneal tissue] said substantially overlapping pattern is achieved using randomized scanning of said pulsed laser beam on said corneal tissue.

27. (Amended) A method for performing ophthalmic surgery according to claim 24, wherein:

said pulsed laser beam [provides an energy level of no greater than 50 mJ per pulse to said corneal tissue] has an ultraviolet wavelength.

28. (Amended) A method for performing ophthalmic surgery according to claim 24, wherein:

said pulsed laser beam has a spot size on said corneal tissue of no greater than 1 mm.

A1 cont.

29. (Amended) A method for performing ophthalmic surgery according to claim 25, wherein:

said pulsed laser beam has a spot size on said corneal tissue of no greater than 1 mm.

30. (Amended) A method for performing ophthalmic surgery according to claim 26, wherein:

said pulsed laser beam has a spot size on said corneal tissue of no greater than 1 mm.

31. (Amended) The method for performing ophthalmic surgery according to claim 27, wherein:

said [laser beam has a spot size on said corneal tissue of no greater than 1 mm] ultraviolet wavelength is in a range of 193 to 220 nm.

32. (Amended) The method for performing ophthalmic surgery according to claim 24, wherein:

successive pulses of said pulsed laser beam are overlapped at least 50 percent.

33. (Amended) The method for performing ophthalmic surgery according to claim 24, wherein:

said [laser beam is pulsed at a repetition rate of at least 20 Hz] ultraviolet wavelength is in a range of 193 to 220 nm.

34. (Amended) The method for performing ophthalmic surgery according to claim 24, wherein:

said pulsed laser beam [is pulsed at] has a repetition rate [of at least 20 Hz] in a range of 50 to 200 Hz.

A1 cont.

35. (Amended) The method for performing ophthalmic surgery according to claim 24, wherein:

said pulsed laser beam is scanned synchronously with said pulses of said pulsed laser beam.

36. (Amended) The method for performing ophthalmic surgery according to claim 24, wherein:

an area of corneal tissue 0.05 to 0.5 microns deep is removed with each pulse of said pulsed laser beam.

39. (Amended) A method for performing ophthalmic surgery, comprising:

providing [pulsing] a laser outputting a pulsed laser beam having [at] an energy level of no greater than [20] 10 mJ per pulse from an output coupler of said laser[onto corneal tissue]; and

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scanning said pulsed laser beam in a substantially overlapping pattern on [said] corneal tissue.

40. (Amended) The method for performing ophthalmic surgery according to claim 39, wherein:

said pulsed laser beam has a spot size on said corneal tissue of no greater than 1 mm.

41. (Amended) The method for performing ophthalmic surgery according to claim 39, wherein:

successive pulses of said pulsed laser beam are overlapped at least 50 percent.

42. (Amended) The method for performing ophthalmic surgery according to claim 39, wherein:
said pulsed laser beam is pulsed at a repetition rate of at least 20 Hz.

A2 cont

43. (Amended) The method for performing ophthalmic surgery according to claim 39, wherein:
said pulsed laser beam is pulsed at a repetition rate of at least 50 Hz.

44. (Amended) The method for performing ophthalmic surgery according to claim 39, wherein:
said pulsed laser beam is scanned synchronously with said pulses of said pulsed laser beam.

45. (Amended) The method for performing ophthalmic surgery according to claim 39, wherein:
an area of corneal tissue 0.05 to 0.5 microns deep is removed with each pulse of said pulsed laser beam.

A3

48. (Amended) A method of performing laser ablation on tissue, said method comprising:
providing a laser having a pulsed output beam of ultraviolet wavelength and an output energy level of no greater than 10mJ per pulse from an output coupler of said laser;
providing a galvanometer scanner; and
controlling said pulsed output beam with said galvanometer scanner to provide a substantially overlapping [random] pattern of beam pulses on said tissue.

49. (Amended) The method of performing laser ablation on tissue according to claim 48, wherein:
[said pulsed output beam has an energy level of no greater than 10 mJ per pulse] an orientation of said substantially overlapping pattern is achieved using randomized scanning of said pulsed output beam on said tissue.

50. (Amended) The method of performing laser ablation on tissue according to claim 48, wherein:
said pulsed output beam has [an energy level of no greater than 20 mJ per pulse] a pulse repetition rate of at least 20 Hz.

A4

56. (Amended) The method of performing laser ablation on tissue according to claim 48, wherein:

said pulsed output beam [has an energy level of no greater than 50 mJ per pulse] is pulsed at a repetition rate of at least 50 Hz.

59. (Amended) The method of performing laser ablation on tissue according to claim [56] 50, wherein:

said pulsed output beam has a spot size on said tissue of no greater than 1mm.

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61. (Amended) The method of performing laser ablation on tissue according to claim [48] 49, wherein:

said pulsed output beam [is pulsed at] has a repetition rate of at least 20 Hz.

62. (Amended) The method of performing laser ablation on tissue according to claim [48] 57, wherein:

said pulsed output beam [is pulsed at] has a repetition rate of at least [50] 20 Hz.

A6

69. (Amended) An [Apparatus] apparatus for ablating tissue, comprising:

a laser adapted to emit a pulsed output beam [of] having an ultraviolet wavelength and [at] a repetition rate of at least [20] 50 Hz; and

a scanner constructed and arranged to control said pulsed output beam into a substantially overlapping [random] pattern of beam pulses on said tissue.

70. (Amended) The apparatus for ablating tissue according to claim 69, wherein:

said [repetition rate is at least 50 Hz] substantially overlapping pattern of beam pulses has an orientation which is achieved using a randomized scanning of said pulsed output beam on said tissue.

A7

76. (Amended) An ophthalmic surgery apparatus for performing corneal refractive surgery by reshaping a portion of a corneal surface, said apparatus comprising:

a laser adapted to emit a pulsed laser beam having an energy level of less than [20] 10 mJ per pulse from an output coupler of said laser [onto said corneal surface]; and

a computer-controlled scanning device coupled to said laser to cause overlap of pulses of said pulsed laser beam on said corneal surface to achieve a smooth ablation of corneal tissue.

77. An ophthalmic surgery apparatus for performing corneal refractive surgery by reshaping a portion of a corneal surface according to claim 76, wherein:

said [smooth ablation results in a surface roughness of less than about 1 micron] pulsed laser beam has a repetition rate of at least 20 Hz .

78. (Amended) A method of performing corneal refractive surgery by reshaping a portion of a corneal surface, said method comprising:

substantially overlapping a plurality of ultraviolet laser beam pulses over an area of a corneal surface sufficient to ablate a depth of between 0.05 and 0.5 microns of corneal tissue per ultraviolet laser beam pulse;

said laser beam pulses having an energy level of no greater than [20] 10 mJ per pulse from an output coupler of said laser; and

said laser beam pulses having a pulse repetition rate of at least 50 pulses per second.

79. (Amended) The method of performing corneal refractive surgery by reshaping a portion of a corneal surface according to claim 78, wherein:

said laser beam pulses have [an energy level of no greater than 10 mJ per pulse] a wavelength in a range of 193 to 215 nm.

A8

82. (Amended) An ophthalmic surgery apparatus, comprising:

a laser adapted to emit a pulsed beam of less than about [20] 10 mJ per pulse at an output coupler of said laser; and

a computer-controlled scanning device coupled to said laser such that pulses of said beam are substantially overlapped to achieve a smooth ablation of corneal tissue.

A9

84. (Amended) The ophthalmic surgery apparatus according to claim 82, wherein:

said laser is adapted to emit a pulsed beam [of no greater than 10 mJ per pulse] having an ultraviolet wavelength.

A10

86. (Amended) The ophthalmic surgery apparatus according to claim 82, wherein:

said laser [has] is adapted to emit a pulsed beam having a repetition rate [in a range] of at least 20 [50 and 50,000] Hz.

A11

90. (Amended) A method for performing corneal refractive surgery by reshaping a portion of a corneal surface, comprising:

selecting a laser having a pulsed output beam of ultraviolet wavelength and having an energy level less than 10 mJ/pulse from an output coupler of said laser;

selecting a scanning mechanism for scanning said laser output beam[, said scanning mechanism including a galvanometer scanning mechanism for controlling said laser beam into an overlapping pattern of adjacent pulses];

coupling said laser beam to said scanning mechanism for scanning said laser beam over a predetermined surface;

focusing said scanning laser beam onto [a] said corneal surface;

controlling said scanning mechanism to deliver the scanning laser beam in an overlapping pattern onto a plurality of positions on [the] said corneal surface to photoablate or photocoagulate corneal tissue; and

removing from 0.05 to 0.5 microns of corneal tissue per pulse overlapped to remove tissue to a desired depth, whereby a patient's vision is corrected by [the] said reshaping of [the] said portion of said corneal surface of [the] said patient's eye using a low power laser.

91. (Amended) A method for performing ophthalmic surgery, comprising:

pulsing an ultraviolet laser beam having an output energy level of no greater than 10 mJ/pulse from an output coupler of said laser;

applying said pulsing ultraviolet laser beam onto corneal tissue; and

scanning said pulsing laser beam in a purposefully substantial overlapping pattern on said corneal tissue.

92. (Amended) The method for performing ophthalmic surgery according to claim 91, wherein:

said pulsing ultraviolet laser beam [is pulsed at a repetition rate of at least 20 Hz] has a wavelength in a range of 193 to 215 nm.

95. (Amended) The method of performing ophthalmic surgery according to claim 91, wherein:

[said pulsing ultraviolet laser beam provides an energy level of no greater than 10 mJ per pulse to said corneal tissue] said substantially overlapping pattern is achieved using a randomized scanning of said pulsing laser beam on said corneal tissue.

A12

96. (Amended) The method of performing ophthalmic surgery according to claim 91, wherein:

said pulsing ultraviolet laser beam [provides an energy level of no greater than 20 mJ per pulse to said corneal tissue] has a wavelength of 193 nm.

100. (Amended) A method for performing photocoagulation on a corneal surface according to claim [100] 99, wherein:

A13

said infrared laser beam is emitted by a diode laser having a wavelength in a range of 1.9 to 2.5μm.

Kindly add the following new claims 105 and 106.

------ 105. (New) The method for performing corneal refractive surgery according to claim 90, wherein:

said scanning mechanism comprises a galvanometer.

A14

106. (New) The method for performing corneal refractive surgery according to claim 90, further comprising:

aligning a center of said scanning laser beam onto said corneal surface with a visible aiming beam.-----

Remarks

By this amendment, claims 24-36, 39-45, 48-50, 56, 59, 61, 62, 69, 70, 76-79, 82, 84, 86, 90, 91, 92, 95, 96 and 100 are amended, and new claims 105 and 106 are added. Thus, claims 1-106 are currently pending in the present application.

Although the Applicant is under no obligation to respond to the public protest filed by a third party on March 18, 1999, the following comments on the references cited by the protest are offered merely to help the Examiner in determining the relevancy and/or multiplicity of these references.

Reference 1: US Patent 4,718,418 to L'Esperance, Jr.

This '418 patent is specifically cited in the '679 Lin patent as a reference that was already considered by the Examiner during the original prosecution of the Lin patent. The reference generally teaches the use of a high energy laser having an output energy of 200 mJ/pulse (See Col. 3, line 59 to Col. 4, line 20). In contrast, current claims of the present application recite a laser having **low** output energy. For example, claims 1, 25, 39, 48, 71, 76, 82, 90 and 91 recite a laser having an output energy level of **no greater than 10 mJ/pulse from an output coupler of the laser**.

Reference 2: US Patent 4,665,913 to L'Esperance, Jr.

This reference is a parent application of reference 1 ('418 patent) above. The '913 patent essentially contains the same disclosure as the '418 patent, and likewise fails to disclose, teach or suggest, *inter alia*, the claimed **low** energy, high repetition rate laser of the present application. (See Col. 3, line 53 to Col. 4, line 14).

Reference 3: US Patent 4,838,679 to Bille

The '679 patent to Bille discloses an apparatus and method for "examining eyes". According to Bille, "gentle examinations" of human eyes are performed by illuminating the eyes with a broad laser beam, and a beam reflected from the eyes is detected with a photo-detector. The examination is to be performed "by utilizing UV-radiation of comparatively high intensity without inconveniencing a person subjected to examination." The UV laser beam of Bille is for illumination purpose, and thus does not reach photoablation threshold (PAT) level. Moreover, Bille fails to disclose, teach, or suggest ophthalmic surgery, photoablation or photocoagulation, much less using a low power, high repetition rate laser as variously claimed by the present application.

Reference 4; European Patent Application No. 0296982A1 by Hanna

Hanna discloses reshaping of an object, e.g., a cornea, by laser ablation. According to Hanna, a laser beam is directed to the object through a lobe shaped narrow slit that can be rotated between discrete ablations.

Hanna uses a diaphragm/aperture mechanism, and is NOT a scanned laser as is the present invention. Hanna teaches the use of a **high** energy **180 mJ/pulse** laser (See page 5, lines 53-57). Hanna fails to disclose, teach or suggest a laser having a **low** output energy, i.e., **no greater than 10 mJ/pulse** as variously claimed by the present application.

References 5, 6 and 7: Ren et al., "Corneal Refractive Surgery Using An Ultra-violet (213 nm) Solid State Laser, "SPIE Vol. 1423 Ophthalmic Technologies (1991), Ren et al., "Ablation of the Cornea and Synthetic Polymers Using a UV (213 nm) Solid-State Laser," IEEE Journal of Quantum Electronics, Vol. 26 (December 1990), and Gailitis et al., "Solid State Ultraviolet (213 nm)Ablation of the Cornea and Synthetic Collagen Lenticules," Lasers in Surgery and Medicine 11:556-562 (1991).

Reference 5, 6 and 7, all reporting the same laser system, disclose the use of a **high** power laser having an **output energy level of 40 mJ per pulse**, operated at a low repetition rate of 10 Hz, and having an infrared wavelength (1064 nm) at an output coupler (See Fig. 2 of reference 5 and Fig. 1 of references 6 and 7). The high power infrared 1064 nm laser output is attenuated using harmonic generation crystals to ultimately provide an ultraviolet laser beam (213 nm). In contrast, all current claims of the present application recite a **low** power laser having an output energy level of **no greater than 10 mJ/pulse**. Moreover, some claims recite a high repetition rate ablation (enabled by the low power laser) of, for example, at least 50 Hz.

Reference 8: J.T.Lin, "A Multiwavelength Solid State Laser for Ophthalmic Applications," SPIE Vol. 1644 Ophthalmic Technologies (1992).

This reference, by the present inventor, is not prior art to the present application. The present application is a re-issue application of US patent 5,520,679, which issued from a continuation-in-part application No. 07/985,617 that was filed on December 3, 1992. Reference 8 was published in January of 1992, less than one year before the earliest filing date (December 3, 1992) of the present application.

Proper support for all present claims including the ablation rate range is found in the parent '617 application filed on December 3, 1992.

Furthermore, even if Reference 8 were to be construed as prior art against the present application, it nevertheless still fails to disclose, teach or suggest, e.g., the recited laser having an output energy level **no greater than 10 mJ/pulse**. Instead, Reference 8 teaches the operation of laser beam converted from the output of a Nd:YAG laser having an infrared wavelength (1064 nm), and a high energy level of about 40 mJ/pulse from an output coupler. Reference 8 fails to disclose, teach or suggest, *inter alia*, a laser having an output energy level **no greater than 10 mJ/pulse** as variously claimed by the present application.

References 9 and 10: L'Esperance, "Ophthalmic Lasers," Chapter 24 Corneal Laser Surgery, The C.V. Mosby Co., St. Louis (1989). and L'Esperance, "Ophthalmic Lasers," Chapter 26: New Laser Systems, Their potential Clinical Usefulness, and Investigating Laser Procedures", The C.V. Mosby Co., St. Louis (1989).

References 9 and 10 teach the use of a gas excimer laser having a **high** output energy level of **100 mJ/pulse**, or an ArF laser having a **high** output energy level of **200 mJ/pulse** (e.g., see Reference 9, page 926).

Neither Reference 9 or Reference 10 discloses, teaches or suggests a laser having a **low** output energy level of less than **10 mJ/pulse** and/or high repetition rate enabled by such a low power laser, as variously recited.

Early and favorable examination on the merits of the present application is earnestly solicited.

Respectfully submitted,

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Date

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